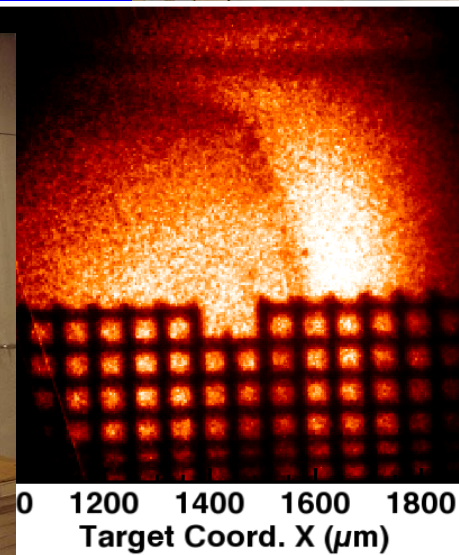
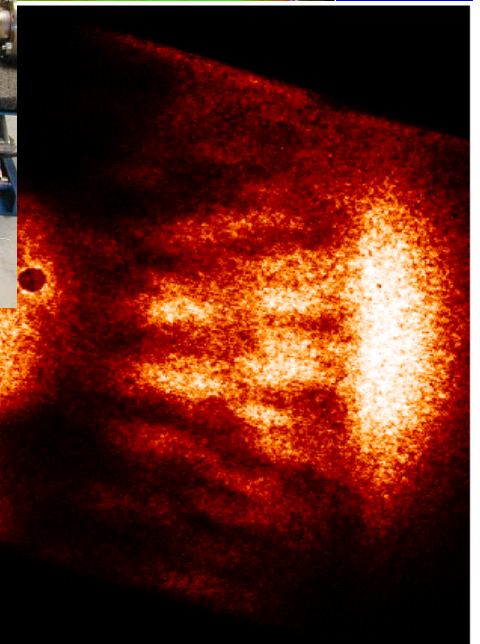
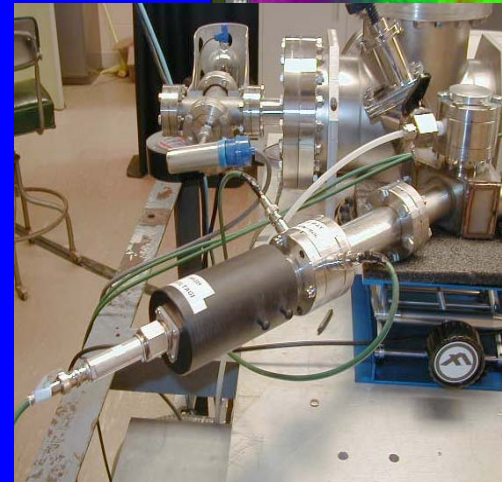
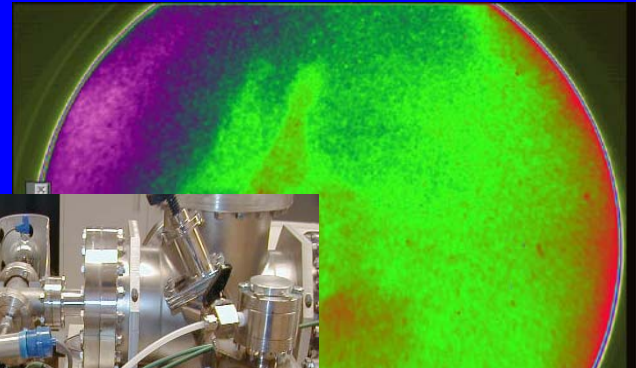


# Using the Major High-Energy-Density Facilities as a University Professor

R. Paul Drake  
*University of Michigan*

*May, 2004*



600 800 1000  
Target Coord. X ( $\mu\text{m}$ )

Work supported by the U.S. Department of Energy under grants DE-FG03-99DP00284, DE-FG03-00SF22021 and other grants and contracts

# This talk concerns who what and how



- **Who am I?**
  - Why am I qualified to discuss this subject?
- **What**
  - modes of use of HED facilities are possible and desirable?
  - in the world can one do about targets?
  - does it take to get design support?
  - about diagnostics?
  - would I say about existing programs?
- **How could one create a national community of HED users?**
  - Are the HED laboratories the answer?
- **My narrow task: Life as a (university) user**
  - No time to share the great HED physics we've done that way

# My acknowledgements hint at qualifications

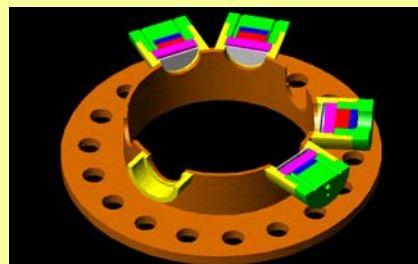
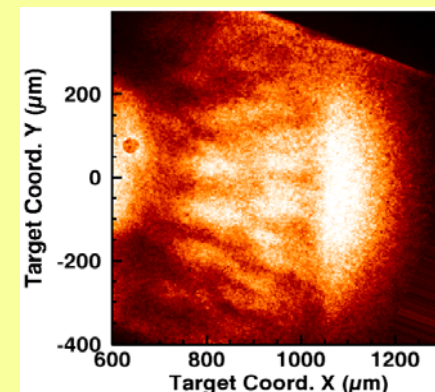


- **My group at Michigan**
  - Korbie Dannenberg, Amy Reighard, Melanie Blackburn, Carolyn Kuranz, Eric Harding, Peter Susalla, Dave Leibrandt, Mike Grosskopf, Doug Kremer, Saida Caballero, and UROP students Trisha, Jon, Zheng, & Ko
- **Collaborators from**
  - NRL: James Weaver, Yefim Aglitskiy
  - SNLA: Tom Mehlhorn, Marcus Knudson, and ....
  - LLE & U of R: Jim Knauer, Tom Boehly, Adam Frank
  - LLNL: Bruce Remington, Harry Robey, Gail Glendenning, and ...
  - LANL: Bernie Wilde, Nels Hoffman, and ....
  - Chicago/FLASH: Bob Rosner, Tomek Plewa, Alexei Khokhlov, and ...
  - SUNY: James Glimm and Yongmin Zhang
  - Princeton: James Stone
  - CEA: Serge Bouquet, Laurent Boireau
  - LULI: Michel Koenig, Tommaso Vinci
- **Support from DOE/SSAA, DOE/NLUF, NRL, SNLA**

# We have comprehensive specific experience



- My group at Michigan has
  - Done shots through Science Use of Nova
  - Done many shots at Omega through the National Laser User Facility
  - Done shots at Trident supported by Los Alamos
  - Put targets on the schedule then the shelf at Z, supported by Sandia
- In addition we are now
  - Preparing for experiments on NIKE supported by NRL
  - Involved in planning discussions for experiments on NIF



## Some context on university finances is essential to the following discussion



- Inflation exists
  - One's notions about costs get old fast
- What should a university group be?
  - Apprentice mode seems outdated, expensive, and inefficient
  - Experience in a group of students is worthwhile
  - Undergraduates and participation in the community add a lot
- The professor's job is to pay for all this
  - Grad students who do nothing cost 53 k\$ this year at Michigan.
  - In reality one must pay for the student, the professor, hardware, travel, computers, undergrads, and technical support.
  - The loaded cost of an experimental student might be 200 k\$, or perhaps more.
- So a group with 5 students and limited technical staff would need 1 M\$ (this year).



Eric Harding  
(Graduate Student)



Saida Caballero and Koichi Murai  
(Undergraduate Students)



# There must be fifty ways to use your laser...



- ... but perhaps three limiting cases
- **The participating guest investigator**
  - Experiments performed by a facility team
  - University involvement is peripheral and very personality dependent
  - Very limited funding: no way to sustain a grad student program
- **The collaborator with big labs**
  - University personnel participate essentially in experiments
  - Collaborators from big labs carry vital loads too
    - For example targets, diagnostics, organization, simulation
  - This is the mode my group is mainly in now at > 500 k\$ per year
- **The independent experimenter**
  - University personnel conduct the experiment on their own
  - Would require more technical staff
  - Would require abilities in targets, simulations, diagnostics, etc
  - Consistent with vision of a community but these are 2 M\$/yr groups
  - There are no such facility-using groups today in HED physics

# The problem of mistakes



- In sharp contrast to small university labs, one can afford few mistakes in a big-facility environment.
- The is doubly true when one must compete for limited access
- In the end this drives up costs.
- Checking the students' conclusions falls on
  - The professor whose time is constrained
  - The big lab collaborator whose time is constrained
  - Other students if they exist
  - University scientific staff if they exist
- The traditional mode of throwing a student into a lab and telling them to come out when they have something does not work here.

# Targets are an enormous challenge



- They cost a lot
  - Comparable to the laser time. 10 k\$ per shot and up from the labs
- They are part of the experiment
  - Target design is nearly always a tradeoff among science, cost, and feasibility
  - Targets need to change from one shot day to the next
  - No way to specify and forget, and more thinking improves the spec
- I am skeptical about using third party suppliers for entire targets
  - Targets are a 3D CAD problem but universities aren't staffed for this
  - Supplying target components from third parties seems excellent
- Our approach at Michigan
  - We began by relying on big labs and still do
  - We also now build targets
  - This has very strong educational benefits
  - At the cost of some technical support

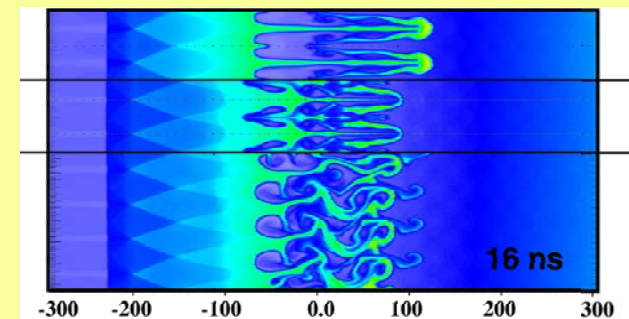
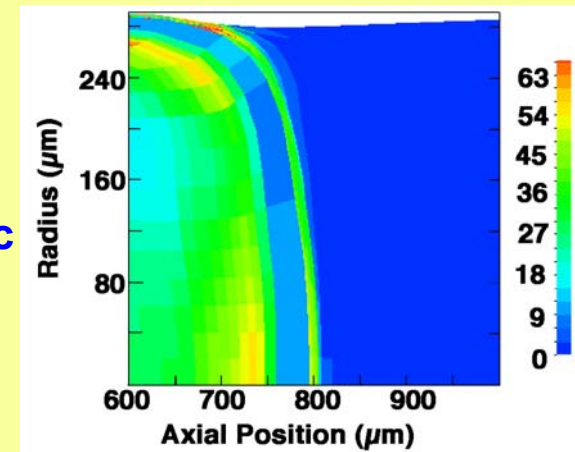




# Design simulations are another challenge



- 1D design is easy
  - There are a couple of good tools and we use them
- 2D design is hard
  - Needed for effects of walls, edges, finite laser spot, etc
  - No good tool exists outside the fence
  - Even if it did, this is hard for an experimental group
  - No one inside the fence can make a career of design support
- Astrophysicists are nearly useless for this (sorry)
  - They run 3 simulations and write a paper (an exaggeration)
  - Design requires dozens of simulations and the paper often comes years later
- Design-oriented university groups could flourish
  - But only as part of a well funded community
- Meanwhile one catches as catch can
  - Cheers for random students here and in France



## **Diagnostics could be an issue and are an opportunity**



- Experiments depend essentially on diagnostics
- Across facilities, diagnostic support and options vary
  - at the moment my group relies heavily on LLNL for work at Omega
- The HED community also is lacking an important element
  - There are few (perhaps one?) groups that develop diagnostics for HED facilities as a major activity
  - This eliminates a source of improved technologies
  - It also eliminates one natural mode of interacting with facilities
  - Other communities use university diagnostic groups extensively and effectively
  - This is a proven mode way to get technology, training, and broad participation!!

## Some comments on specific user programs



- **Science use of Nova**
  - Got some basic science and some university involvement
  - Very much guest investigator mode
- **National Laser User Facility**
  - A good model overall
  - If one wants to build a university community then student involvement should be a review criteria
  - Targets have not been addressed (might be changing)
  - Historically very underfunded (in the context of HED univ. funding)
- **MIAs**
  - NIF (This is supposed to be a *National Facility*. Good Grief! )
  - Trident (might take a LANL culture change or very dedicated funds)
  - Z (might take a SNLA culture change or very dedicated funds)
  - NIKE (perhaps an issue of mission)

# So how could one build a community of university users of HED facilities?



- **The HED laboratories are not the answer**
  - We have tremendous, positive interactions with individuals and groups
- **But the institutions seem unable to sustain the long view needed by Ph.D. students**
  - Livermore seems unable to look more than 6 months ahead
    - NIF should have a university program launching but does not
  - Los Alamos seems to manage their money so they are always broke
    - Trident should be funding university users but is not
  - Sandia tries to; seems to be constrained by their success
    - Sandia supports some university groups but involvement in Z is limited
  - LLE Rochester does a good job with their funded user program
    - They stick close to it, too
  - Current Nike management takes the long view but it's a small program
- **The answer is money from agencies to the universities**
  - Need quite a few pots each at several M\$ per year and up
  - Need some 2 M\$/yr groups
  - Need a variety of user programs on different facilities
  - Need to address targets and design support in the process

## The bottom line



- There is the precursor to a High-Energy-Density Physics university community
- But there is not yet more than a glimmer of a community of HED facility users
- There are technical and institutional issues .....
- But money is the big limitation

# The book and the Summer School



- I expect to finish the draft of *High Energy Density Physics* this summer (to be published by Springer-Verlag)
- Taught at Michigan in 2003
- Summer School in High Energy Density Physics
  - in Traverse City this August
- Topics covered:
  - Fundamental Equations and Equations of State
  - Shocks, Rarefactions, and their Interactions
  - Hydrodynamic Instabilities
  - Radiative Transfer
  - Radiation Hydrodynamics
  - Creating High-Energy-Density Conditions
  - Inertial Fusion
  - Experimental Astrophysics
  - Relativistic Systems